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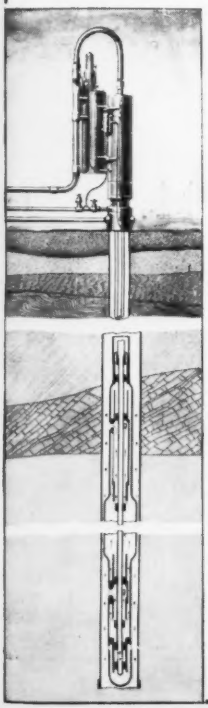

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SOME ASPECTS OF AUTOMOTIVE DESIGN AND DEVELOPMENT*

By CHARLES L. GOODACRE
(*Associate Fellow*)

The petrol engine is the greatest prime mover in the world to-day, accounting for more potential power contrived by man for his use than any other mobile device, with some 3000 million horse-power in land vehicles alone. It is difficult to think what type of engine can supersede the petrol engine for automotive use in the foreseeable future.

Bearing in mind the universal "know how" in this engine and the vast amount of time and money that has been invested in personnel, plant and equipment, to design, build and operate petrol-engined vehicles, the way the petrol engine serves is admirable from every angle, especially in view of its simplicity and ever-increasing durability.

It is suggested that the more or less orthodox piston engine operating on the four-stroke cycle with poppet valves will be our principal automotive engine for at least the next fifteen years. The reason it will continue to use petrol as a fuel is because with existing refinery technique petrol represents by far the largest and most easily expanded cut from the barrel of crude oil.

Gas turbines and other devices may become serious competitors to the piston petrol engine, eventually replacing it in the automotive field, but it seems that

* Précis of an address to the Northern Branch of the Institute on April 12, 1948.

in the next twenty years few will be riding about in cars propelled by turbines or "other devices".

Any new type of engine will have to show outstanding promise early in its development to be worth going on with. Many variations of the simple four-stroke petrol engine have in the last thirty years been heralded as *the* engine of the future, only to fall by the wayside into oblivion.

In regard to what form the engine will take in the motor vehicles we shall use for the next twenty years, it appears, for the majority, that the piston engine will operate on the four-stroke cycle. It will have poppet valves, primarily because this valve system gives good results, is cheap, reliable, has high mechanical efficiency, is universally understood, and does not lead to problems of high oil consumption or acute thermal difficulties.

The side-valve engine in Europe is dying fast, if not already dead. In America there are still some die-hards clinging to, and even designing new side-valve engines, but the more progressive groups in that country are dropping all side-valve engine development.

There are very good reasons for dropping the side-valve engine, the chief one being that it is almost impossible to compression a side-valve engine over 7·5 : 1 and retain a reasonable shape of combustion chamber with adequate valving. The cooling problem is more difficult and servicing of the valve gear can be very awkward. Further, the advantage on trucks of having a replacement head with serviced valve gear, thus cutting overhaul delay for the vehicle, cannot be obtained as on the overhead valve engine.

The logical engine arrangement in the next few years appears to be as shown in Fig. 1. This type can be compressioned almost to infinity without serious restriction to breathing. It is cheap, and engines so designed can be made on plant used for producing side-valve engines, without too much alteration to tooling. Further, the cooling of the valves is adequate and easily coped with. There are no complex casting or lubrication problems, and almost as much can be got from this arrangement as from the so-called classical semi-spherical combustion chamber arrangement with twin overhead camshafts with their attendant problems of drive to camshafts, lubrication, duplication of shafts, extra weight, and consequent extra cost and servicing problems, etc.; further, the detonation control on the latter type of head is poor unless the bore is small. (See Fig. 2.)

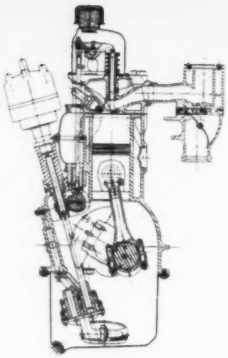

Fig. 1

A six-cylinder high-compression engine.

An alternative arrangement which is being resurrected is the so-called F-head engine, or inlet over exhaust type, which has been on the edge of the stage for many years (Fig. 3). There seems little advantage in this arrangement over the simple overhead-valve engine (Fig. 1) with the possible exception that on a large six- or eight-cylinder in-line engine, this arrangement might save some length or a restriction of valving. There seem several snags to the F-head arrangement, the main one being that of increased cost. It must be very irritating, from a production and maintenance

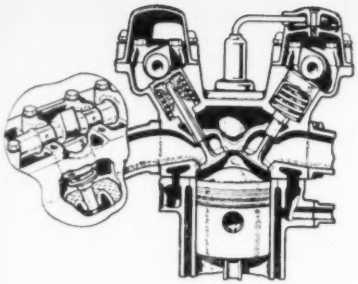

Fig. 2

point of view, to have to do a valve job in the block, as well as in the head. The exhaust valve does not look too easy to get at or to cool. The provision of manifold heat with an orthodox carburettor layout becomes a problem, due to the inlet and exhaust manifolds usually being on different sides, as with the semi-spherical head layout in Fig. 2. Valve springs will probably have to be of different design to cope with inlet and exhaust valves, principally because the former involve the extra weight of push rod and rocker. This means some duplication in provisioning. From a performance point of view, it appears that the F-head has little to offer over the layout in Fig. 1 and will probably be inferior to the layouts in Figs. 1 and 2 on sheer power. In considering these three layouts, it is assumed that all three would be naturally aspirated.

There appears to be little future for supercharging in anything but sports or racing engines and, maybe, heavy trucks, primarily because of the complication and cost of the supercharger, and the reduction in part load fuel economy suffered with supercharging. Also lubrication problems on superchargers are apt to be very acute unless fairly complicated and expensive glanding is used.

Superchargers may, however, be used for heavy truck engines when the space available and the weight allowance for the engines are limited; in the case of

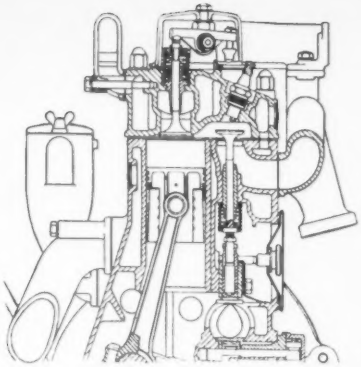

Fig. 3

The F-head engine.

these vehicles, the initial cost is high anyhow, so the installation cost of the supercharger can be passed on to the customer for what benefit it gives in obtaining maximum power with a fuel of a given octane number.

It may well be asked why do petrol engines have to be designed for higher and still higher compression ratios? The answer is that the higher the compression ratio within limits the higher the thermal

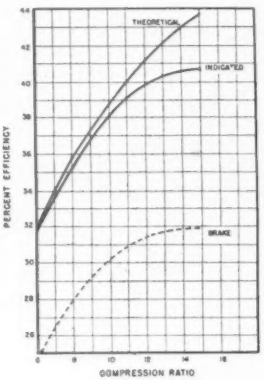

Fig. 4

Thermal efficiency, single-cylinder high-compression engine.

efficiency of the engine and the more the work extracted from a pound of fuel with less heat energy going to waste. Thus, the high-compression engine shows better fuel economy, which must be considered an all important factor in these days of fuel shortage.

The advantage to be gained by using a high compression ratio will be obvious from Fig. 4; the increase in efficiency is not a straight line. As the compression ratio rises, so the law of diminishing returns shows itself. And the ability to use high compression ratio is largely tied up with the ability of the oil industry to increase the octane number of petrol economically. The use of high compression ratios naturally increases the resultant compression pressures, peak firing pressures in the engine, and the demand on the fuel to resist knock. These increases in pressure are shown in Fig. 5. To meet these pressures and the consequent increased mechanical shock loads in the engine structure, it is necessary to build more stiffness into the engine. A petrol engine of 12 : 1 compression ratio would have to be built with scantlings to diesel proportions, or even more so, if the volumetric efficiency of the engine is good.

Therefore, when establishing new basic types with no immediate chance of using compression ratios in the order of 10 : 1 to 12 : 1, it is desirable to construct the crankcase casting in such a way that the necessary stiffness is already built in to this structure, or can be conveniently achieved with a minimum of alteration to patterns; this may inevitably result in building some apparent redundancy into the basic type of engine, which may start life with a compression ratio of 7 : 1 and finish its life as a type in, say, fifteen years, with a compression ratio of 10 : 1 to 11 : 1, or even 12 : 1.

It is suggested that compression ratios of over 10 : 1 in new cars will not be in general use within the next fifteen years, but a lot will depend on what the oil industry can do to produce high octane fuels for road transport economically, and on the development of transmission systems.

The above situation makes the square engine, i.e., the engine with bore and stroke equal, look more attractive, because of its greater inherent crankcase rigidity and shaft strength due to shorter crank throw. Shaft stiffness is essential to overcome torsional vibration due to increased pressure loadings on the crank pins with increase in compression ratio.

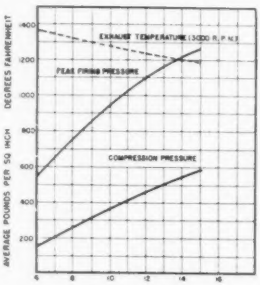

Fig. 5

Compression and firing pressures, single-cylinder high-compression engine.

The square engine is also attractive from the point of view of lowering piston speed and consequent resultant reduction in cylinder bore wear, as the square engine, other things being equal, seems less prone to this bugbear, still one of the major troubles with the modern petrol engine. Also, the square engine leaves more room for adequate valving with the arrangement shown at Figs. 1 and 2, and push rods can be kept short in the case of Fig. 1 and reduce deflection in this member and inertia loading of the valve gear in general.

Perhaps British manufacturers should say a prayer for the Chancellor who, in a moment of brilliance, freed the industry from tax engineering.

It appears that if Fig. 1 is accepted as the logical basic type for the next

fifteen years for passenger cars, the following cylinder arrangements will be most in evidence:

(a) *Up to 120 cu. in. cylinder capacity—straight, vertical, four-cylinder.*
(b) *For 120 to 240 cu. in. cylinder capacity—straight, vertical, six-cylinder.*
(c) *Over 240 cu. in. cylinder capacity—wide V.8 cylinder arrangements, probably 90 Vee.*

In the case of (c), the V.8 arrangement is favoured, and may predominate in numbers for this class of engine, because of:

1. *The desire for a short, stiff crankshaft for the power developed, somewhere in the order of 170–190 b.h.p.*
2. *To improve driver's vision, the majestic bonnet like a carrier flight deck may please the stylist, but certainly does not help the driver.*
3. *To economize space. How often one lifts the bonnet of a super-luxury car to be impressed by the amount of engine fore and aft ways, and the large amount of space on either side.*

Engine Position

It appears that, in general, for passenger cars the engine will stay in the front of the car; for trucks, it is felt that this position will also predominate, though not to such a marked degree, as the problem is somewhat different. The over-riding consideration for the front position for passenger cars seems to be the natural desire on a high-speed vehicle to have the largest concentration of mass between the driver and the accident; this is a very old—a very common sense—point of view. Also, with this orthodox layout, installation, transmission, control, and servicing problems are very conveniently coped with. Further, it is unnecessary to resort to fancy rear suspension systems.

For trucks, the ratio of mass of engine to vehicle, plus load, is usually much wider and speeds are lower, and this argument probably does not apply so much. For buses, the rear engine position seems almost ideal, providing an automatic transmission, and an efficient engine speed governor device is built into the bus. It seems rather an imposition to seat the heavy vehicle driver almost on top of his engine, and if this is done it must reduce the resistance to fatigue of this all-important person.

Type

In regard to what type of passenger car is to have the most universal appeal within the next few years, the concensus of opinion seems to be that the optimum future type will be around a 2000 to 2200 lb car weight with comfortable accommodation for six passengers and some luggage, powered by a 140 cu. in. (2·3 litre) engine doing over 30 miles per Imp. gal. at a cruising speed of 60 m.p.h., with a useful continuous maximum speed of around 80 m.p.h.

This seems quite a reasonable target for designers to aim at in the light of present knowledge and available materials. And there are strong indications that they are thinking along these lines.

Material of Construction

It appears that ferrous metals will continue to be the main construction materials for private and commercial vehicles for many years. Plastics will, no doubt, be used in increasing quantities for members carrying low stress, such as body fittings, etc., probably replacing non-ferrous alloys. The use of non-ferrous alloys for main structural members seems to be, in general, opposed on account of cost, difficulty of deep drawing, lack of resistance to coolant and weather corrosion and some doubtful weight saving, all of which may be argued at great length.

Transmission

One of the major developments which is now taking place on passenger cars and trucks is the development of the

transmission system. In the very early days of the motor car it was realized that some form of semi-automatic or automatic transmission system was desirable, and many praiseworthy efforts were made to develop automatic transmission systems.

Unfortunately most of these fell by the wayside, due to lack of suitable materials and the extreme complication which these systems involved. Everyone knows that to get the best out of a petrol engine it is necessary to provide some means of altering the gear ratio between the engine and the rear wheels, in order to meet all driving conditions between zero and maximum speed. In the early part of the twentieth century, Panhard and Levasseur's development of the crash type sliding pinion gear box solved the problem in rather a brutal manner. In the early 1920's it was realized that this type of gear box must be superseded by something better, and many praiseworthy efforts were made to develop epicyclic gear boxes, etc. At this time the most popular car in the world had been fitted with a two-speed epicyclic gear box for some considerable time, this being made possible by a fairly high power to weight ratio. However, most of the efforts made in the 1920's fell short of practical requirements because:

1. *The power to weight ratios of the vehicles were just not good enough.*
2. *The automatic systems envisaged were not production propositions for anything but the most de-luxe cars which had, due to their size, fairly high power to weight ratios, and where cost was not a primary consideration.*

The ultimate solution at that time was undoubtedly the introduction of the synchro-mesh principle to the sliding pinion gear box. This in itself was an enormous step forward in conjunction with the application of constant mesh gears, and sliding dog clutches, which in themselves had their engagement synchronized by friction clutches. Now, however, with the upward trend in specific engine performance and attempts to reduce car weight, i.e., improve power to weight ratio, automatic transmission systems again appear to look attractive.

Developments of automatic transmission systems will help to accelerate the introduction of the high-compression engine, because such transmission systems, if properly designed, will make it impossible for the driver to load the engine heavily at low rotational speed, which is usually the knocking speed.

The weakness of any automatic transmission system is that, being a mechanical device, it cannot anticipate, and therefore the performance of any car with an automatic transmission system will probably be inferior to that of a car with a semi-automatic transmission system, over which the driver can exert his will. In the hands of a good driver the latter will always give the best performance. There are many automatic transmission systems now under intensive development, both in the U.K., in Europe, and in the States, the most promising of which appear to be based on well-tried epicyclic principles. Some of these devices are extremely complicated, and it is quite amazing how American production technique has got down to producing such transmission systems as the General Motors' hydromatic at a reasonable cost.

It can be fairly stated that many of these automatic transmission systems can cost more to build than the engine which drives them, and this cost has to be passed on to the customer.

It appears that any car manufacturer who intends to remain in business in a big way in future is going to have to put a considerable amount of effort into the development of transmission systems, in order to simplify the operation of his cars. Further, these transmission systems will have to be both reliable and cheap, and not suffer any thermal problems.

FUEL

Table I forecasts how tetraethyl lead will continue in use as the most practical method of achieving high resistance

TABLE I

T.E.L.	Grade	Octane Number A.S.T.M. Research
By 1950:		
At 1·8 c.c Imp. gal.	Regular	80 86–87
At 2·4 c.c Imp. gal.	Premium	83–84 90–91
By 1956:		
At 1·8 c.c Imp. gal.	Regular	83 91–92
At 2·4 c.c Imp. gal.	Premium	89 100

of a fuel to knock in conjunction with improved refining processes such as catalytic cracking, etc.

It will thus be seen that, in general, lead concentrations of up to 2·4 c.c./Imp. gal. be expected for premium fuel, and 1·8 c.c/Imp. gal. for regular or commercial grade in the U.S. area. These concentrations may be exceeded outside the U.S. in some areas, but it is felt that, in general, averages will not be over 2 c.c/Imp. gal. for commercial or regular grades or "house brand", world wide. For the home and European market, if and when the world supply position permits, the author feels that the logical starting octane number for the commercial grade of fuel is 75 O.N. (Motor Method). Should a premium fuel become available it will probably have to have at least 8 O.N. (Motor Method) appreciation over the prevailing commercial grade.

A survey of British cars in present production shows the bulk of these require approximately 75 O.N. (M.M.) fuel when optimum basic spark settings have been established, and the vehicle has accumulated some 2000 miles or more of combustion chamber and coolant system deposit. The ability to use higher compression ratios will depend on the availability of higher octane fuels and, to some extent, the development of automatic transmissions.

General Motors research have successfully operated their 12·5 : 1 compression-engined car on a high sensitivity fuel of 87 O.N. (M.M.), 99 O.N. (Research Method).

Research rating is now considered in the States to give a better indication of a fuel's resistance to knock on the road in a passenger car. It is becoming common practice in the States to quote Research Method ratings before Motor Method ratings, i.e., the fuel mentioned would be referred to as 99/87 O.N.

It may be of interest to say here that premium fuels in the States are now running 80 O.N. (M.M.), 89 O.N. (R.M.), thus showing 9 O.N. sensitivity. These fuels are considered by some to be good enough for cars of 8·5 : 1 compression ratio providing the combustion chamber design is reasonably good, though the motor industry in that country are asking for 83/91 O.N. fuel for cars with this compression ratio, because they want some margin to cope with deposit build up.

There appears to be some discussion taking place in the American oil industry as to whether or not it is a commercial proposition to market a premium fuel of 83/91 O.N. at the present time, and whether the waste of "octane numbers" in existing equipment is justified or not at this time.

Sales of premium fuels in America have been much higher than anticipated immediately after the war; this has meant much wastage of octane numbers, as existing American equipment, with one or two notable exceptions, can mostly operate very well on their regular or house-brand grade of 76 to 82 O.N.

As far as the U.K. is concerned, the industry, with few exceptions, will design engines for the second, commercial, or whatever it may be called, grade. Most of these engines will probably benefit by a premium grade but the performance achieved will not be up to that of an engine specifically designed for a premium grade.

Development of refining technique and equipment, by such processes as

catalytic cracking, etc., will be the governing factor as to what the sterling area can do to help itself towards achieving a better quality fuel and thus better cars, which are more competitive in the world's markets. Although we may be behind the Americans on fuel quality for many years, and this will probably be some handicap to our motor industry in the overseas markets, the handicap need not be as heavy as some people think.

Valves

Poppet valves are in almost universal use for automotive engines, and it has already been submitted that this position will continue for some considerable time. As far as the American automotive industry is concerned, it has been realized for some time that better exhaust valve material than Silchrome 1 must now be used to meet present and future engine performance made possible by fuel development. There are strong signs that British and European makers are also similarly inclined. The first major job on any new car is usually a valve job. Valve life should at least match re-ringing mileage, or 50,000 miles as a target on any engine, however cheap. This has already been done on the car with the highest production rate in the world.

The most popular exhaust valve steels in the States are in the semi- or fully austenitic-range, being Silchrome XB 2112 and XCR, all of which have 19 to 24 per cent of chromium, and are thus completely cold corrosion resistant, coupled with good resistance to hot corrosion. The most popular inlet valve steel in the States appears to be 3140.

Some makers are using exhaust valves of two piece construction with 2112 or XCR heads welded on to 3140 stems, to conserve austenitic steels which are expensive and in short supply. More forward thinking British manufacturers are now on something better than Silchrome 1 for exhaust valves, and favour XB.

Some truck engines using petrol as a fuel have hollow forged exhaust valves, sodium cooled, with hard facing materials such as Stellite or Brightray. These valves bear on hard inserts of high Brinell iron or steel with, in some cases, a facing material similar to that used on the valve. This technique is in line with aircraft practice, and is very expensive, but is justified when the maximum power per exhaust valve is high, in the order of 30 b.h.p. or over.

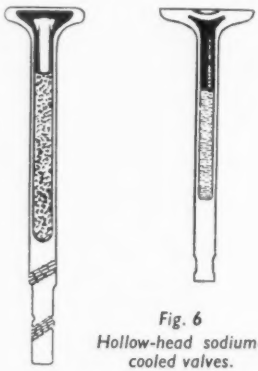

Fig. 6
Hollow-head sodium-cooled valves.

Considerable interest and development is taking place to cheapen the sodium-cooled exhaust valve of the hollow head type, and bring the cost under 5*s.* per valve. Fig. 6 shows two methods of achieving this. Valve makers propose to hollow forge the cavity head valve, fill it with the requisite amount of sodium—about 60 per cent—and flash weld a valve cap on to the valve head. A considerable number of valves of this design were produced in America during the war for tank engines, but with rather a high percentage of scrap in the welding operation, which is very critical, as too short a flash produces a porous weld and too long a flash fills the head cavity with slugs of metal slag.

Good guide cooling with sodium

cooled exhaust valves is essential. The sodium-cooled valve is not a cure-all for valve burning, especially when valve trouble due to poor guide cooling or block designs is experienced. The application of sodium-cooled valves to an engine with poorly cooled guides will usually make matters worse rather than better, and the valves will probably stick sooner, due to the inability of the guide to deal with the thermal load, imposed upon it by the improved heat flow down the valve stem caused by the sodium vapour in the hollow valve. This state of affairs results in rapid deposit build up on the valve stem, causing stick and the possibility of scuffing, and eventual valve seat failure by burning or guttering.

Valve closed spring pressures seem to be averaging about 45 to 50 lb for passenger cars and small truck engines in the States, and 75 to 90 lb for larger engines. Valve seat widths are being kept around 1/16 inch for smaller engines and about 3/32 inch for the larger engines. When valve seat inserts are used these are generally of the pushed in or interference fit types of deep section.

Valve Rotators

The development of the valve rotator was originally undertaken in the States during the war in order to eliminate exhaust valve trouble from certain engines without major re-design.

Some think that this device, which gives controlled valve rotation in the case of "A" and some haphazard semi-controlled rotation in the case of "B" as distinct from valve spin induced by weak valve springs, is the biggest single step forward to increase valve life in automotive engines since the general introduction of high chrome valve steels. When applied to passenger car engines without valve seat inserts or specially faced valves, the valve life with rotation is usually about doubled. For engines on heavy or continuous duty, such as truck engines or water pumping engines, which already have specially faced valves and inserts, quite extraordinary results have been obtained. In some cases the increased valve life of these engines has been as high as five times with rotation. While there is still much development going on on valve rotators, and the devices at the moment are rather expensive, in the order of 1*s.* 6*d.* per unit, valve makers think that they can make the device for approximately 6*d.* per unit if a large demand warranted high quantity production and rapid amortization of special tooling.

The gradual rotation of the valve is effective because the valve does not seat continually at the same position on the seating in the block or head, and any local hot spot which develops will not thus progressively increase the valve temperature at one point; further, the seat face will be wiped clean by rotation. Rotation also helps to keep the valve stems clean of deposit and prevents sticking.

Tappets and Camshaft Design

Automatic self-adjusting tappets of either the hydraulic or mechanical type are gradually gaining some ground. The hydraulic type seems to be the only variety in quantity production so far, and it is quite popular in the truck and better quality passenger car field in the States. British manufacturers are already looking at this device, and the hydraulic tappet, because it removes the bugbear of adjustment, has made more practical the simple valve gear shown at Fig. 1 on the side camshaft push rod operated overhead valve engine.

Protagonists of these automatic tappets claim that better valve dynamics result from their use. The application of self-adjusting hydraulic tappets should be a basic design job right from the start, and an adequate supply of clean de-aerated oil must be provided.

Spark Plugs

The main spark plug makers in the U.K. and America seem to be going over to the sintered aluminium oxide type of insulator as a result of experience gained during the war. There are no serious troubles with electrode erosion at present but it is possible that as compression ratios and engine specific power output go up there may be some real problems on electrode life and electrical ignition problems in general.

Carburation

General opinion is that for passenger car work the carburettor will remain for some time. However good direct fuel injection may be made, cost will rule this system out for passenger car engines for a considerable time. With the tendency to lighter fuels, it is felt by some that less manifold heat is required, with consequent improvement in volumetric efficiency when using carburettors. These people usually consider a thermostatically controlled hot spot to be of paramount importance for good engine life, fuel economy and good performance.

The carburettor man seems to aim at maximum power air/fuel ratios of about 12·5 : 1 by weight, and some are thinking of part throttle ratios of 17·5 : 1 in conjunction with vacuum spark control and power jet accelerator pump operation on the carburettor.

The dual carburettor layout, using two under-capacity carburettors, cruising on one and using two for over 80 per cent of maximum power, shows to advantage on power and economy, but appears to be very tricky to engineer satisfactorily. Good performance can be had for a long time to come from a single carburettor with, maybe, a double venturi assembly for six cylinders or more.

There are some truck engineers who think that direct fuel injection may come quite soon for the heavier type of truck, as the estimated cost of £6 per cylinder is not prohibitive if the system can justify itself on performance and economy.

Lubrication and Filtration

Light lubricating oils are becoming more generally accepted now as right practice, and SAE 30 oils for trucks and 10 or 20 for passenger cars give very satisfactory performance in temperate operation, providing the vehicle is started from new with these grades. There is a tendency to go up one grade or more for tropical operation. Detergent oils will probably replace non-detergent oils in all fields of operation eventually, although it does not appear practical to use one type of detergent for the whole automotive field. The problem of additive oils is complex.

There seems to be a considerable diversity of opinion on the use of oil filters. Most truck engine makers fit some form of oil filter. Some engineers have, however, stated that the important thing in their opinion is to clean the carburettor and crankcase ventilating air properly, and if this is done they have yet to be convinced from data they have seen so far, that an oil filter further reduces wear in engine parts, which is, after all, the object in fitting it. These engineers think that many people are over-impressed by the amount of sludge that an oil filter collects, and neglect to realize its main object in life, i.e., reducing engine wear. One maker, who is the biggest user of hydraulic tappets in the world, does not fit an oil filter even though it is claimed that these devices need clean oil for satisfactory operation. One assumes that he does a good job of carburettor and crankcase air cleaning, as he gets very few service complaints of stuck tappets.

To sum up, it appears that the orthodox automotive engine will be with us for many years, and the emphasis will be on thermal efficiency as fuel quality can be improved. Transmission development on passenger cars will be of paramount importance, and value for money will be more than ever of primary consideration.

COUNCIL COMMENTARY

THE approach of Christmas possibly affected the attendance of members at the December meeting of the Council, there being fewer than usual but enough for a quorum.

After the minutes were confirmed and signed, a discussion took place on information supplied by the General Secretary that the monogram was about to be produced by the printers and that the crest was in the hands of the College of Heralds.

A very slight alteration, suggested by Colonel Auld, was agreed by Council as an improvement on the design then under discussion, and the altered design was then passed by Council for production.

Reports from election, research, branches, and public relations committees were passed, with little need for comment or discussion, the latter including the announcement that the Institute dinner had been fixed for March 1, 1949, and acceptances had been received from the Rt. Hon. Hugh Gaitskell, Sir Andrew Agnew, Sir Frederick Bain and the president, in connexion with the toasts of the Institute and the industry.

New matter was the acceptance, with regret, of the resignation from the chair of the Finance Committee of Mr T. F. Laurie, owing to his taking up residence in Ireland, his place being filled by Mr Hyams on the unanimous vote of Council.

The House and Finance Committees brought forward a joint report dealing with suggested staff changes, which were approved in principle, and the House Committee was empowered to act on these recommendations.

The president also advised that the Association Française des Techniciens du Pétrole were holding a conference in Paris in 1949, at which Britain and the U.S.A. were being asked to supply papers on the chemical side.

Messrs Oriel and Tett having supported the proposal, it was agreed by Council and handed over to Publications Committee for action.

The honorary secretary announced the nomination of members of Council retiring, in accordance with by-laws, as follows, all being eligible for re-election:

V. C. Illing	A. Beeby Thompson
J. A. Oriel	A. T. Beazley
H. C. Tett	R. R. Tweed
F. L. Garton	

(The two latter as a result of the drawing of lots.)

Of general interest was the report of the joint meetings of By-laws and Election committees under the chairmanship of Colonel Auld, and their findings were accepted as guiding principles governing the grading of applicants for membership of the Institute.

THE I.L.O. PETROLEUM COMMITTEE

WHEN the Petroleum Committee of the International Labour Organization met in Geneva for its second session in November last, the four main items on the agenda were:

1. *General report;*
2. *Recruitment and training;*
3. *Safety and health;*
4. *Industrial relations.*

In connexion with each of these items special reports have been published by the International Labour Office, 38–39 Parliament Street, London, S.W.1, and are available for purchase.

Thus, Report I (64 pp., price 1*s.* 6*d.*) deals first with action taken on resolutions adopted at the first session in June 1948. Then follows a chapter on the result of studies proposed at the first session, this being mainly concerned with the question of hours of work in the industry, with a short note on labour

statistics. The final chapter discusses the growth of demand, supplies and reserves, and world expansion of the industry with notes on the expansion in individual countries.

Report II (73 pp., price 2*s.*) opens with a chapter on employment in the industry, which is followed by discussions on recruitment, qualifications, education and training, and the role of organizations in dealing with employment problems.

Safety is the subject of Report III (18 pp., price 6*d.*), and it is stated in the conclusions that the importance of maintaining works' safety committees or some other form of internal safety organization has been recognized in virtually all countries where the petroleum industry is carried on.

In Report IV (42 pp., price 1*s.* 3*d.*) industrial relations are examined first from the aspect of the I.L.O. and then in particular reference to the petroleum industry.

THE CALCULATION OF GALLONAGES FROM CUBIC FEET

ACCORDING to this Institute's "Tables for the measurement of oil", a cubic foot contains 6·2288 Imperial gallons. In rough calculations, it is usual to take this as $6\frac{1}{4}$ gallons, which leads to gallonages about 0·34 per cent too high. The error is negligible for small gallonages, but it may sometimes be worth correcting for larger quantities. How this may be done simply is discussed below.

The conversion of 1234 cubic feet (C) to gallons is taken throughout as an example of the working of the factors proposed. Direct calculation of the product $1234 \times 6{\cdot}2288$ gives 7686·3 gallons.

1. The usual factor $6+\frac{1}{4}$ leads to the following calculation:

6C	7404
C/4	308·5
Gallons	7712·5

the error in excess being 26·2 gallons or about 1 gallon in 300.

Knowing that the excess is 1 in 300, the calculation may be corrected:

Approx.	+7712·5
—1/300	— 25·7
Gallons	7686·8

the residual error, still in excess, being reduced to about 1 gallon in 15,000.

Allowing for the fact that the figures 7712·5 would not be rewritten, this correction leads to a three-line calculation being increased to five lines. Results can, however, be improved, still keeping to three-line or four-line calculations.

2. If the factor is amended and written 7—7/9 or 7 (1—9) a three-line calculation,

+7C	+8638
—7C/9	— 959·8
Gallons	7678·2

leads to a result in error by 8·1 gallons in defect, or nearly one gallon in 900.

This factor, therefore, gives results with about a third of the error of the usual $6\frac{1}{4}$ factor. Apart from its being more accurate, an alternative factor is often useful in checking, since it avoids direct repetition of a previous calculation.

3. For a better four-line calculation, the factor may be rewritten as $6+\frac{1}{8}+\frac{1}{7}\cdot\frac{1}{5}$, or $6+\frac{1}{5}\,(1+\frac{1}{7})$, thus leading to:

6C	7404
C/5	246·8
C/7×5	35·3
	7686·1

the error in defect being about one gallon in 37,000, which seems good enough. Involving as it does the consecutive numbers, 5, 6, and 7, or rather 6, 5, and 7, the factor is easily remembered.

"BY SEA AND AIR TO SOUTH AMERICAN OIL"

On December 15, 1948, an audience of about 150 at Chester Town Hall had tropical oil areas brought vividly to them on the screen on the occasion of the first joint meeting to be held between the Stanlow Branch of the Institute of Petroleum and the Liverpool and North-West Sections of the Royal Institute of Chemistry and of the Society of Chemical Industry.

An hour's film entitled "By Sea and Air to South American Oil" was shown by J. S. Parker (a vice-president of the Institute), and was a record of a trip made by him earlier in the year to the oil regions of the Caribbean and of Peru and Ecuador.

Prior to the showing of the film, the lecturer exhibited a number of slides depicting scenes in Trinidad, the Dutch West Indies, Peru, and Ecuador. The film which followed, after indicating the amenities accompanying travel on modern tankers, showed details of the oilfields and refineries in Trinidad, including views of the famous Pitch Lake, and proceeded to illustrate, in a striking manner, the gigantic scale of petroleum refining and storage operations on the islands of Aruba and Curaçao in the Dutch West Indies.

The main part of the film then went on to deal with the oilfields and installations in Peru and Ecuador operated by Lobitos Oilfields Ltd. and their associated company, Anglo-Ecuadorian Oilfields Ltd. The barren and desolate nature of the landscape and the considerable difficulties which drillers have to encounter in this steeply indented region of the oil-bearing areas of the Peruvian and Ecuadorian seaboards were clearly shown in a number of scenes taken among the wells and pipelines. Shots of the "blue balls", which have already been the subject of a note in the *Review* (1948, p. 214), gave an interesting picture of this odd geological formation.

Apart from numerous views of oil installations, the film gave an excellent idea of the type of living accommodation available in these regions and did not omit the lighter side of the overseas oilman's existence, as exemplified by golf courses and swimming pools.

Much of the film was in colour, and the brilliant hues of West Indian tropical beaches probably made many of those present feel that perhaps they would have liked to have accompanied the "Thornton" cracker to its new home in sunnier climes far removed from the winter mists of Merseyside.

A feature of the film much appreciated by those not too familiar with the geography of the West Indies and South America was that each section was preceded by an appropriate map on which the route of the trip, together with the names of the places visited, was clearly marked, thus enabling a correct perspective of the region covered to be obtained.

At the conclusion, the appreciation of the audience for this out-of-the-way lecture, which gave many unacquainted with overseas petroleum producing and refining conditions a far clearer picture than can be obtained from any source other than a personal visit, was expressed in a vote of thanks which was proposed by Dr J. B. Matthews (R.I.C.) and seconded by E. T. Williams (S.C.I.).

TANK CLEANING METHODS

"Some notes on tank cleaning methods for tanks which have contained leaded gasoline" is the latest addition to the *Ethyl* manual, published by the Associated Ethyl Co., Ltd., Artillery House, Artillery Row, London, S.W.1.

PERSONAL NOTES

Emile E. Soubry, recently chairman of Anglo-American Oil Co. Ltd., has been elected to the board of Standard Oil Co. (New Jersey) as from January 1. He started his career in oil in 1911 as a junior clerk in "Anglo's" shipping department and worked his way up until in 1930 he was elected chairman. During the recent war he served on the British Oil Trade Committee, and in 1943 was appointed foreign marketing co-ordinator for "Standard." Since October 1947, he has conducted all the Company's overseas marketing operations.

J. B. Aug Kessler, F.Inst.Pet., has been appointed chairman of the Royal Dutch Petroleum Co. in succession to *W. H. van Leeuwen*, who retired from that position in December 31, 1948, but who remains on the board. *B. Th. W. van Hasselt* has been appointed to succeed Mr Kessler as director general.

R. T. Haslam, F.Inst.Pet., has been appointed to serve on the National Committee on Financing Development of the Massachusetts Institute of Technology.

A. E. Robins has resigned his membership of the Stanlow Branch Committee, and his place has been taken by *Dr Norman Kendall*.

L. S. Davis, who previously held the post of contracts manager and head of the Design Department to W. J. Fraser & Co. Ltd., has now been appointed contracts manager, and *C. B. M. Dale* has been appointed head of the Design Department.

A. H. Nissan, F.Inst.Pet., has been elected a Fellow of the Royal Institute of Chemistry.

Dr Frank Morton, F.Inst.Pet., has resigned his position as chief chemist to Messrs. Trinidad Leaseholds, to accept an appointment as reader in chemical engineering at the University of Birmingham. Dr Morton is a member of Council and chairman of the Research Committee of the Institute. He was for many years superintendent of research and development at the Pointe-a-Pierre Refinery of Trinidad Leaseholds Ltd., and for several years Hon. Secretary and Treasurer of the Trinidad Branch of the Institute.

William Blackwell, M.Inst.Pet., has been made a member of the Transport Consultative Committee for Great Britain.

Dr N. L. Anfilogoff, F.Inst.Pet., was one of the six successful candidates in the recent election for the Standing Committee of the Convocation of the University of London.

LEDUC DEVELOPMENTS

It is reported that work is in progress by Imperial Oil Ltd. on an absorption plant and repressuring system for the Leduc Field, Alberta. It will be equipped to handle 24 million cu. ft. of gas daily from which 500 barrels of natural gasoline will be extracted prior to the gas being used for repressuring to increase the flow of crude oil.

It was also announced by the president of the company that a $35,000,000 pipeline from Leduc to Regina will probably be started in the spring of 1950 and is planned to handle 40,000 barrels a day with one pumping station or 100,000 barrels a day with more stations. The present line from Leduc to Nisku siding has a potential capacity of 35,000 barrels daily.

The Photographic Survey Co. of Toronto announces that a mosaic strip-map of some 400 vertical air photographs has been delivered to the Imperial Pipeline Co. for use in planning a new 16-in. pipeline from Nisku to Regina. This map covers an area 466 miles long and 3 miles wide, and the photographs were taken in about three hours' flying time.

NOMINATIONS FOR COUNCIL, 1949-50

The following candidates have been nominated by Council in accordance with By-laws 64, 65, 68, 69:

PRESIDENT

E. A. Evans, M.I.Mech.E., F.R.I.C., F.Inst.Pet. (Chief Chemist, Messrs C. C. Wakefield & Co. Ltd.).

VICE-PRESIDENTS

M. A. L. Banks, B.Sc., F.R.I.C., F.Inst.Pet. (Manager of Operations Branch, Refining Division, Anglo-Iranian Oil Co. Ltd.).

E. J. Dunstan, M.Sc., F.Inst.Pet. (Director, Manchester Oil Refinery Ltd.).

E. B. Evans, Ph.D., M.Sc., F.R.I.C., F.Inst.Pet. (Research Co-ordinator, Esso Development Co. Ltd.).

H. Hyams, F.Inst.Pet. (Section Head, Technical Division, Shell Petroleum Co. Ltd.).

J. S. Parker, M.A., B.Sc., F.Inst.Pet. (Refinery Manager, Lobitos Oilfields Ltd.).

C. A. P. Southwell, M.C., B.Sc., F.Inst.Pet. (Managing Director, Kuwait Oil Co. Ltd.).

HON. TREASURER

G. H. Coxon, F.Inst.Pet. (Anglo-Iranian Oil Co. Ltd.).

HON. SECRETARY

C. Chilvers, B.Sc., F.R.I.C., F.Inst.Pet. (Manager, Costs & Operations Dept., Anglo-American Oil Co. Ltd.).

The above names will be submitted for the approval of the Corporate Members at the Annual General Meeting on April 27, 1949.

MEMBERS OF COUNCIL

The following nominations have been received for seven vacancies on Council in accordance with By-law 72:

RETIRING VICE-PRESIDENTS ELIGIBLE FOR RE-ELECTION TO COUNCIL

J. A. Oriel, C.B.E., M.C., B.Sc., F.R.I.C., M.I.Chem.E., F.Inst.F., F.Inst.Pet. (General Manager, "Shell" Refining & Marketing Co. Ltd.; Chief Chemist, Shell Petroleum Co. Ltd.). Chairman of Petroleum Industry Standards Committee and of Petroleum Equipment Industry Standards Committee of the B.S.I. Chairman of I.P. Branches Committee and Member of Benevolent Fund, Finance, and Research committees.

H. C. Tett, B.Sc., A.R.C.S., D.I.C., F.Inst.P., A.M.I.Mech.E., F.Inst.Pet. (Managing Director, Esso Development Co. Ltd.). Member of I.P. Awards and Benevolent Fund committees.

RETIRING MEMBER OF COUNCIL ELIGIBLE FOR RE-ELECTION

F. L. Garton, M.A., B.Sc., A.R.I.C., F.Inst.Pet. (in charge (acting) of Sales Technical Advisory Dept., Shell Petroleum Co. Ltd.). Chairman of I.P. Aviation Products Data Committee, Deputy Chairman of Standardization Committee, Member of Publications Committee and of Papers Sub-Committee.

NEW NOMINATIONS

V. Biske,* LL.B., B.Sc., F.R.I.C., F.Inst.Pet. (Research Chemist, Lobitos Oilfields Ltd.). Treasurer of I.P. Stanlow Branch, Member of By-laws, Publications, and Standardization committees and of Library and Papers Sub-committees.

R. J. Bressey, M.A., B.Sc., A.R.I.C., M.Inst.F., F.Inst.Pet. (Assistant Fuel Oil Manager, Shell-Mex & B.P. Ltd.). Member of I.P. Liquid Fuel

* Present ex-officio Member of Council.

Installations Committee, of Standardization Sub-Committee No. 4, and of the Liquefied Gases Panel.

C. D. Brewer,* M.I.Mech.E., F.Inst.Pet. (Engineer in Charge of Research Engine Services Section, Thornton Research Centre, "Shell" Refining & Marketing Co. Ltd.). Chairman of I.P. Stanlow Branch Committee, Deputy Chairman of Mechanical Tests of Lubricants Panel, and Member of Engine Tests of Lubricants Panel.

H. S. Gibson, M.A., M.I.Mech.E., F.Inst.Pet. (Formerly General Fields Manager, Anglo-Iranian Oil Co.Ltd.).

J. G. Hancock, M.Inst.Pet. (Technical Assistant, "Shell" Refining & Marketing Co. Ltd.). Hon. Secretary, I.P. Stanlow Branch and Member of Branches Committee.

E. W. Hardiman, B.Sc., M.Inst.Pet. (Manager, Motor Fuels Dept., Anglo-American Oil Co. Ltd.). Member of I.P. Publications Committee.

C. H. S. Haygarth, B.A., F.Inst.Pet. (Assistant General Manager, Shell-Mex & B.P. Ltd.).

E. C. Masterson, B.Sc., F.Inst.Pet. (Technical Assistant to Managing Director, Kuwait Oil Co. Ltd.).

R. G. Mitchell, F.R.I.C., M.Inst.Pet. (Chief Chemist and Manager of Technical Dept., Eagle Oil & Shipping Co. Ltd.). Member of I.P. Nomenclature Sub-Committee and of Classification Panel.

H. W. Sanson, M.Inst.Pet. (Manager of Operation Divn. and Shipping Divn., Eagle Oil & Shipping Co. Ltd.). Member of Shipping Federation Council.

R. B. Southall,* F.Inst.Pet. (General Manager, National Oil Refineries Ltd.). Member of I.P. Election, Engineering, and Branches committees.

T. C. G. Thorpe, F.Inst.Pet. (Manager, Technical Sales Dept., Anglo-American Oil Co. Ltd.). Deputy Chairman of I.P. Standardization Sub-Committee No. 8, and Member of Abstracts Sub-Committee.

AUSTRALIAN OIL SEARCH

It is reported in an article in *Chemical Engineering and Mining Review* by D. E. Morgan (geologist in charge, Shell (Queensland) Development Pty Ltd.) that the company expects to drill a deep test during 1949 and if necessary will drill to 10,000 ft.

The same journal reports that the Kariava well on the Vailala river, in Papua, was completed in March 1948 at 12,621 ft. No oil was found but much useful geological information was obtained. The rig has been erected at a new site at Hohoro, near the mouth of the Vailala river. Two other wells are in course of drilling, one at Oroi, some 60 miles north-west of Port Moresby, and the other at Upoia, about 25 miles up the Vailala river. These operations are being undertaken by the Australasian Petroleum Co. Pty. Ltd.

NEW BELGIAN REFINERY

It has been announced that the Anglo-Iranian Oil Co. Ltd. and the Cie Financière Belge des Petroles S.A. (Petrofina) are to form a jointly-owned company (Soc. Industrielle Belge des Pétroles S.A.) to construct and operate an oil refinery at Antwerp. Initial intake capacity will be 30,000 brl/day and a petroleum dock to accommodate large tankers will be constructed by the Port Construction. Work will begin this year and it is anticipated that the refinery will be in operation in 1951–2.

The "Albatros" S.A. Belge pour le Raffinage de Pétrole (changed in January from "Redeventza" S.A. Belge pour le Raffinage de Pétrole) announces that its Antwerp refinery, which was badly damaged during the war, has now been reconstructed and resumed operations in January. Estimated throughput is 120,000 tons per annum.

SAFETY IN THE PETROLEUM INDUSTRY*

By B. L. STOREY

PLANNING for the safety of employees is fundamentally a management responsibility, an integral part of the overall programme of effectively managing any enterprise necessitating the employ of people. The Trinidad oil industry employs 16,000 people, including contractors. Successfully applied safety education will make our fields and refineries better places for them to work.

An intelligently promoted safety programme is initially one of prevention: prevention of injury to personnel, prevention of lost time and loss of earnings, and prevention of the undermining effect of these on the industry and the economic security of the people employed in it.

There is a large amount of evidence to show that systematic training in safe working practices and operating procedures has appreciably reduced the frequency of accidents in industry in other countries, more particularly in Great Britain and the United States.

There appears to remain no doubt that a safety programme that is properly balanced, sensibly related to the practical difficulties obtaining, can serve a useful, economic purpose in any industry. It is plain that such a programme can be readily justified on economic grounds in an industry involving such occupational hazards as those of the oil industry.

But purely economic consideration of a course of action on a matter which falls so clearly in the category of industrial relations, is taking a one-sided view of a many-sided picture.

In the successful management of people there is a compelling necessity to maintain consistently a strong moral position. In the past, industry in general has not always given sufficient consideration to this aspect.

For the successful administration of a safety programme, it is a continuing necessity to make decisions on the basis of whether something is right or wrong —not merely on the basis of how much immediate profit or loss is involved.

Efficiency in the operations of winning and refining oil depends in considerable degree on having effective control over personnel, material, and equipment. Records of production, processing, and the related costs are basic essentials in ensuring such control.

A lot of effort is devoted to recording the manner in which material is used, to the operational results obtained from mechanical equipment. It is surely fundamental to record the results being obtained from that equally important part of the investment—the people employed.

There is no doubt that accident frequency is most directly indicative of whether this part of the investment is giving the returns it should, for unsafe practices are generally unsound practices which will inevitably be reflected in production inefficiency.

Consideration of the effects which the introduction of modern tools and equipment, and advanced technical processes, have had in the oil industry, suggests a definite need for the development of a greater degree of adaptability, mechanical instinct, and care by persons employed in the industry, than was perhaps necessary before these facilities existed.

Alterations and increasing variety in the character of the work required of employees, and of the responsibilities devolving on foremen, renders it impossible, in the oil industry to-day, for foremen to satisfactorily carry out, unassisted, effective training in accident prevention.

* Paper read before the Trinidad branch of the Institute of Petroleum.

It would seem desirable, from both the social and economic viewpoint, that in every industrial organization, however small, it should be the duty of some responsible officer to undertake, if only on a part-time basis, the work of organizing systematic education in safe working practices and operating procedures.

The form which this training should take and the extent to which the modern British and North American policy of employing full time safety personnel might be applied, will depend on the company's size, facilities, and operational requirements. Expert advice is readily obtainable from the National Safety Council of America and the British Society for Prevention of Accidents, in respect of detailed information on methods of investigation, recording, and analysis of accidents, compiling of injury statistics, and application of data obtained to a particular safety programme.

In general, management has got to be interested, assume leadership, and formulate a sound framework upon which specific plans can be built, detailed rules and instructions based.

Rules can be enforced, but the degree of active co-operation which will be received will depend largely on the methods of presentation by safety organizers. Co-operation cannot be enforced—it cannot be bought—it has to be earned. It will be earned when it is demonstrated through leadership that the management is entitled to respect and co-operation. When employees are ready and eager to accept leadership and the instructions given them, then well-controlled, efficient operations will result.

An effective way for management to achieve co-operation in safety matters is to form a safety committee of men who are qualified to instruct, demonstrate, and lead. "Qualified" should not be taken to mean purely academic qualifications, but the necessity to delegate responsibility to men whom it is known will get the job done with enterprise, competence and drive, should be clear.

A safety committee, to be effective, must be representative, not only of the varied processes of the operation under consideration, but as far as possible should reflect the point of view of varying levels of responsibility and authority. In this way the work of accident prevention is made easier by a pooling of resources, by obtaining the assistance of several points of view of administration, engineering, and operations executives, field supervisors and foremen.

The assistance of hourly-paid employees can be obtained by promoting safety suggestion schemes with some form of incentive basis, preferably a monetary reward, for good suggestions, and where practicable, by group discussion.

Basic Principles

Though conditions are seldom identical in different organizations, some basis requirements for the promotion of accident prevention are outlined below. The emphasis is on basic rules rather than detail; if the methods are fundamentally sound successful results can be achieved though details may vary.

(1) *The management must appreciate that safety is not something to be picked off the shelf like a pound of tea; is not just a matter of a few fragmentary, disconnected decisions or a printed circular or two. There has to be not merely interest and participation, but active leadership, a clear, stated pattern of procedure in the application of safety regulations—not a retreat from one crisis to another, fixing policies and principles to the change of each day. Management must accept responsibility for not only setting up accident prevention machinery, but for the continuing attention essential for this machinery*

to function effectively. The guiding principle should be to make the field or plant a better place to work.

(2) *In the application of safety, a lot is learned by mistakes. It is essential to record those mistakes as revealed when an accident is investigated. Decisions and action should be based on facts, not on someone's intuition. It is therefore important to institute machinery for:*

(*a*) *investigating accidents;*

(*b*) *recording the results of such investigations; the information recorded must be understandable and usable.*

(3) *As the compilation of accident data is justified only when the information obtained is analysed and applied to safety prevention activities, it follows that definite use must be made of accident records such as:*

(*a*) *fixing responsibility for corrective action when an unsafe condition is found;*

(*b*) *promoting interest in safety among field and operating officials by supplying them with information on the accident records of their departments;*

(*c*) *determining the leading accident problems in order to provide field supervisors and safety committees with information in regard to the most frequent unsafe practices and conditions thus enabling them to concentrate their time and efforts where they are most needed;*

(*d*) *assessing the effectiveness of the safety programme by determining whether the injury record is improving or getting worse, and to compare results with those of similar operations elsewhere.*

(4) *Having established the main causes of accidents by means of recording, it logically follows that the information obtained should be passed on to the men most directly concerned in those operations.*

Safety propaganda should be introduced according to the size and scope of operations, and may take the form of talks by foremen and supervisors and safety letters by executives, organized lectures, safety posters, and films.

(5) *That such propaganda should be integrated with a policy of providing adequate protective equipment for the various operations carried out is clear. That failure to use protective equipment provided, or to observe specific precautionary instructions issued, should be met by rigid disciplinary action, will be readily appreciated by management and employees to be a matter of plain good sense.*

(6) *Accident prevention work can almost always receive stimulation by inter-departmental competitions. Such competitions are usually based on the frequency rate of injuries sustained by employees of the various departments, and are run on an annual basis, awards being made to contest winners in the form of a trophy which is inscribed with the name of the winning department and placed in a permanent position in the main office until won by another department. To maintain interest in the competition, it is a good plan to give recognition to the winning section quarter by quarter.*

(7) *Safety education should be relevant to the work actually being done, and should be factual, fresh, and arresting. It should give the men carrying out the details of operations a renewed awareness of the fact that a bad accident record is a bad operational record.*

Safety should not be viewed as something separate from the operation under consideration—it is an integral part of the progress of getting something done with system, efficiency and economy.

The provision of machinery for enlisting the co-operation of personnel of all levels of authority, and of providing adequate facilities for the promotion

of ideas, is an essential requirement for a healthy industrial organization, not only for advancement of accident prevention but from the viewpoint of achieving those standards of efficiency and output, which will assist the industry in Trinidad to compete with the advantageous economic situation obtaining, under conditions of extremely large production, in the prolific fields of Venezuela and the Middle East.

Finally, for all who share some degree of responsibility for the working conditions of people in the oil industry of Trinidad there is a clear obligation to maintain a continuing effort towards avoidance of accidents. In the years ahead people will, in all British countries, be attaining incomes to permit highest standards of education and of living conditions. They will want better working conditions than existed in the past, they will be justified in wanting a safe place to work. Advancement towards these aims in the oil industry here will, in no inconsiderable measure, be assisted by safety education and its practical application.

LONDON BRANCH

Some fifty members of the London Branch were present at the meeting on November 26, 1948, when S. A. W. Thompson delivered an Address on "Aircraft gas turbines".

After outlining the historical development and basic principles of the gas turbine, the lecturer dealt with the advantages of this engine for aviation and detailed the field of use of both the pure jet and the propeller turbine. A number of examples of both types of engine were described as well as the fuel and lubricants necessary.

The trends of future development of these engines were given.

A large number of questions were put to Mr Thompson, to whom a vote of thanks was proposed by R. D. Streeton.

GAS TURBINE TECHNOLOGY

Power Jets (Research & Development) Ltd. announce that they are continuing their aero-engine and industrial courses at Lutterworth. The next aero-engine courses are April 4–14 and April 25–May 6, and the industrial course is May 16–June 3. Weekly fees are tuition £15 15*s*. and accommodation and meals £3 10*s*. Details are obtainable from the company at 8 Hamilton Place, London, W.1.

In the 1948 veteran car run from London to Brighton this 1900 vintage 6-h.p. Daimler was overtaken by its modern counterpart—a 36-h.p. Daimler chassis, with Hooper coachwork (to-day's price £7001 10s.).

WORLD POWER CONFERENCE 1950

THE theme of the Fourth World Power Conference to be held in London in July 1950 is "World Energy Resources and the Production of Power".

The technical programme, which has just been published and is available from the General Secretary, Fourth World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, shows that the conference has three main divisions.

Division I will be comprised of single reports from each national committee, these reports to survey the energy resources of the country and to give a historical record of developments and utilization of resources since the first conference in 1924.

Division II will consist of individual papers under the comprehensive heading of preparation of fuels. The programme stresses that petroleum is the most important source of liquid fuel and that much attention should be given to the preparation of petroleum and its fuel products. Examples of the subjects that might be dealt with are the principles and technology of such processes as:

(*a*) *Separation by fractionation or solvent extraction;*
(*b*) *Degradation and synthesis by cracking, polymerization, alkylation;*
(*c*) *Refining by physical and chemical methods.*

Papers might also deal with oils from other raw materials and with synthetic processes.

Division III is headed "Production of Power". In addition to the traditional sources of power, papers will be included on gas turbines, jet engines, hot-air engines, tidal power, etc., etc.

CORRESPONDENCE

Correspondence on matters of general interest will be welcomed for inclusion in the columns of the *I.P. Review*.

LARGE SINGLE CRYSTALS OF VARIOUS SALTS

The Office National d'Études et de Recherches Aéronautiques, 3, Rue Léon-Bonnat, Paris XVI^{e}, advise that their laboratories have prepared single crystals of very large size, applicable in optical, spectroscopical and spectrographic work and that these can be supplied to research workers interested.

Very pure crystals of sodium chloride and sodium nitrate, potassium chloride, bromide and iodide, calcium and lithium fluorides, the halogen compounds of thallium, and of silver chloride, are available in the form of prisms, disks, lenses, plates and windows.

Those interested should apply direct to M. Pierre Hazebroucq, Chef du Service Commercial, at the address given, quoting 81567/KC as reference.

ESSO'S NEW TANKER

Christened *Esso Zurich* by Mrs Frank W. Abrams, wife of Standard Oil Co.'s (New Jersey) chairman, the first of fourteen super tankers, with an aggregate cargo capacity of 3,192,000 barrels, was launched on December 4, 1948. This 628-ft. vessel will have a haulage capacity 70 per cent greater than the war-time T-2 type tankers. Five more are expected to be completed during 1949 and the remainder are scheduled for 1950.

TRINIDAD BRANCH

At the 21st Annual General Meeting of the Trinidad Branch, held on November 20, 1948, the following were elected to serve as the Committee for 1949: J. S. Collcott, A. S. Curlett, Dr A. L. Down, F. C. Hamilton, P. E. T. O'Connor, H. W. Reid, C. C. Wilson.

PETROLEUM CHEMICALS IN RELATION TO THE TEXTILE INDUSTRY*

By E. S. PAICE

A VAST number of organic chemicals are involved in one or other of the basic operations in the textile industry, and up to comparatively recently these chemicals have been produced either from coal or from natural animal or vegetable materials. Perhaps the greatest single factor affecting the development of the textile industry in the past three decades has, however, been the rise in demand for petrol for the automobile industry. The consequent development of the cracking process, which in turn has made possible manufacture for a wide range of chemicals of major importance, may be said to be the main contributing factor to progress in the textile field. The manufacture of entirely synthetic fibres to replace or augment the naturally occurring materials would, in many cases, not have been possible were it not for the petroleum chemical industry.

We thus have to-day four sources of raw materials—coal, via coal tar and carbide industries; vegetable oils and fermentation products of grain and molasses; animal sources, e.g., fats; and mineral oil, via the petroleum chemical industry. Chemicals from these three sources can make their impact on the textile industry in four different ways:

1. In synthesis, as in the preparation of true synthetic fibres.

2. In manufacturing processes, e.g., the use of acetone and acetic anhydride in acetate rayon manufacture.

3. In processing, e.g., the use of detergents, dyes, and auxiliaries.

4. In finishing, e.g., in mothproofing, waterproofing, coating, and impregnations.

The development of fully synthetic fibres and semi-synthetic fibres is the dominant factor, and it is generally expected that, particularly with the development of staple fibres, these man-made materials have come to stay.

It is perhaps interesting to consider the range of individual fibres of the regenerated and the synthetic type, which are being commercially produced or are in advanced stages of development to-day, some of which are shown in Table I. The main processors of synthetic fibres in the U.S.A., and the trade names under which the base material reach the market are given in Table II.

To consider the development of organic chemicals from the petroleum industry some figures quoted by Egloff[2] show that in 1925 the first chemicals produced from petroleum, mainly *iso*-propyl alcohol, amounted to less than 70 tons. By 1942 the figure for all petroleum chemicals had risen to some 224,000 tons, but since that period output has risen at a phenomenal rate, reaching 1,700,000 tons in 1946, which represents more than 25 per cent of the total U.S.A. production of organic chemicals. This figure does not include the very large tonnage of benzene, toluene, and other aromatics brought into operation mainly for war purposes, which in 1946 represented another 835,000 tons.

As far as the U.S.A. is concerned, the production of petroleum chemicals other than aromatics is to-day at least 50 per cent greater than the total production of these chemicals from all sources in 1939. In addition, it is estimated that the production of toluene and other aromatics

* Summary of a paper read before the Society of Dyers and Colourists in November 1947, and published in full in the *Journal* of the Society, July 1948

TABLE I

TYPES OF ARTIFICIAL FIBRES

Regenerated Celluloses	*Cellulose Derivatives*	*Natural Linear Polyamides*	*Synthetic Linear Polyamides*	*Polymers*
Nitrocellulose Cuprammonium rayon Viscose rayon	Esters (cellulose acetate–butyrate) Ethers (ethyl cellulose) Mixed ester–ethers	Casein Soya-bean protein Ground-nut protein Maize-meal zein	Nylon Perlon L	Pe-Ce (vinyl chloride–vinyl acetate copolymer) Polyvinylidene chloride Polyethylene Polystyrene Terylene (*terephthalic acid–ethylene glycol copolymer*)

TABLE II

PRODUCERS OF SYNTHETIC FIBRES* IN THE U.S.A.[1]

Basic Material	*Trade-name*	*Producer*
Nylon	Nylon (generic) ..	E. I. du Pont de Nemours & Co.
Vinyl polymer ..	Vinyon, Vinyon D ..	American Viscose Corporation
Vinylidene polymer	Saran	National Plastics Co.
	Velon	Firestone Industrial Products Co.
	Permalon ..	Pierce Plastics, Inc.
Milk casein ..	Aralac	Aralac, Inc. (Division of National Dairy Products Co.)
Glass	Fiberglas ..	Owens-Corning Fiberglas Corpn.
Synthetic rubber yarns	Ameripol ..	B. F. Goodrich Co.
	—	U.S. Rubber Co.
Plastic-coated yarns	Plexon	Freyberg Bros.–Strauss Inc.
Polyethylene ..	Polythene ..	Carbide & Carbon Chemicals Corpn.
	—	E. I. du Pont de Nemours & Co.
Styrene	Polyfibre ..	Dow Chemical Co.
Cellulose acetate–butyrate ..	—	Erie Resistor Co.
	—	Pierce Plastics, Inc.
	—	The Rex Co.
Ethyl cellulose ..	Ethoraon ..	Dow Chemical Co.
Soya-bean protein	Soylon	The Drackett Co.
Maize-meal zein ..	—	Corn Products Refining Co.
Aluminium ..	Raymet, Rayspun ..	Reynolds Metals Co.
Ground-nut protein	—	Bureau of Agricultural and Industrial Chemistry
Sodium alginate	—	—
California redwood	—	—

* Including regenerated fibres other than rayon.

from petroleum sources is now about six times the rate of production from coal-tar.[3]

If we now consider side by side the rapid rise in production of man-made fibres and in the production of organic chemicals from petroleum sources, the connexion is very striking indeed, and this provides the main theme of this paper.

Cracking

Of the various processes now available for producing chemicals from petroleum, that of cracking is the most fundamental and most widely used. It consists essentially in breaking up larger hydrocarbon molecules, such as those in gas oils and fuel oils, into smaller molecules with the intention of obtaining increased quantities of hydrocarbons of suitable boiling range and structure for motor spirit; during this process there is obtained in addition to these liquid hydrocarbons a considerable proportion of gas containing olefins of low molecular weight. These olefins are highly reactive chemicals and form the basis of the chemical industry from petroleum.

The most important olefins utilized for the chemical industry are ethylene, propylene, and the butylenes, and it would be as well to consider the main derivatives from each of these and to indicate whether they may play a part in the textile industry.

Ethylene

By direct treatment with sulphuric acid, ethylene can be hydrated to ethyl alcohol, which of course has applications as a solvent in many operations in the textile industry. Oxidation of the alcohol leads to acetaldehyde and thence to acetic acid, which is an important material in the manufacture of vinyl acetate copolymers as well as in the manufacture of the cellulose acetate used in all dye-houses and print-shops.

Oxidation of ethylene yields ethylene oxide which provides a convenient base material for the manufacture of useful detergents and wetting agents wherein ethylene oxide chains of varying lengths are condensed with alcohols or phenols to give non-ionic surface active materials of considerable value. In some cases these condensates may be sulphated to give products of equivalent detergent efficiency while using a shorter ethylene oxide chain. Such sulphated types are anion-active and have been used in Germany in preference to the non-ionic materials for the washing of cottons.

Ethylene glycol may be obtained either via ethylene oxide or via the chlorhydrin and provides a very useful humidifying agent for use with certain fibres. A commercial process has been developed for the manufacture from this material of glyoxal, used in the treatment of spun rayon for crease-resisting and shrink-proofing. It is also one of the important constituents of that most interesting new fibre Terylene.

Chlorination of ethylene leads via the dichlorides to vinyl chloride, which is the starting-point for the manufacture of a most interesting series of plastics and fibres. Although the main manufacture of vinyl chloride and its polymers has been from acetylene, it is now being produced commercially from petroleum-derived ethylene. The copolymer of vinyl chloride and vinyl acetate is used as the basis for the product Vinyon, a useful fibre having good resistance to chemicals and water, and retaining its tensile strength when wet.

A further interesting material arising from the chlorination of ethylene via trichlorethane is vinylidene chloride. The plastic manufactured by Dow Chemical Co., obtained by copolymerizing this material with vinyl chloride, provides a valuable fibre marketed by National Plastics Company as Saran and by Goodrich Rubber Company as Velon. This fibre is characterized by its properties of toughness and excellent resistance to water and chemicals.

By treatment of ethylene with hydro-

chloric acid, ethyl chloride is formed, and this of course can be reacted with cellulose and caustic soda to yield the ethyl ether of cellulose, which is a very useful plastic material and in addition to its limited applications in the formation of fibres is of considerable interest as a textile-coating material.

Ethylene combines with benzene to form ethylbenzene, which can be readily dehydrogenated to styrene, and this on polymerization yields the plastic polystyrene, which itself has proved of some value as a textile fibre, more particularly in sound-insulating materials.

By direct polymerization of ethylene, useful polymers can be obtained which again are characterized by low specific gravity and high electrical resistance. They have also been used in the preparation of unplasticized fibres, particularly for wrapping and insulating purposes.

Propylene

Propylene was the first of the cracked gases to be utilized in the manufacture of chemicals. After direct hydration to *iso*propyl alcohol it is but a short step further to the dehydrogenation of this material to acetone, which has long been one of the most widely accepted of the heavy organic chemicals. Its outstanding properties as a solvent for cellulose derivatives have naturally led to its utilization as the standard solvent in the commercial production of cellulose acetate, from the solution of which the fibre filament is spun by controlled evaporation of the solvent. Acetone has so many applications that it leads directly and indirectly to a vast number of chemicals, a great many of which find application in the textile industry. Among those of primary importance may be mentioned methyl methacrylate, manufactured via the cyanhydrin and yielding the acrylic resins. These were among the first to be utilized in textile finishing, more particularly for improving the handle and increasing the abrasion resistance, i.e., to obtain the so-called "permanent" finishes. These interesting materials may be obtained also from ethylene oxide and acrylic acid.

Pyrolysis of acetone leads to the formation of keten, which reacts with acetic acid to yield acetic anhydride. The introduction of this process had a profound effect on the rayon industry, since it enabled the cost of acetic anhydride to fall by nearly 50 per cent between 1935 and 1940 and gave a tremendous boost to the development of cellulose acetate fibres.

Acetone may lead, by dimerization, to diacetone alcohol, which in turn forms the basis of other intesesting solvents such as mesityl oxide and methyl *iso*butyl ketone, all of which find applications in the textile industry for solvent purposes. By a similar route hexylene glycol may be obtained; this promises to be a most useful humidifying agent for the textile industry.

Mention must be made of the classic process published by E. C. Williams[4] in 1938 by which, under appropriate conditions of chlorination, the substitution derivative allyl chloride could be obtained in place of the normal addition product. Allyl chloride is readily converted via glyceryl dichlorhydrin to glycerol or alternatively to epichlorhydrin; being highly reactive, allyl chloride provides a most valuable raw material for a number of organic reactions, particularly in the plastic field, and mention may here be made of the allyl ethers of cellulose which provide most interesting compounds for development in the textile industry. Allyl chloride has itself been successfully used in viscose spinning baths to prevent sulphur deposits on the spinnerets. Allyl alcohol can yield very useful resins for use in conjunction with textile fabrics for manufacture of laminates and the recent erection of a full-scale commercial plant in the U.S.A. may lead to considerable developments. An alternative process for the manufacture of allyl alcohol has been

developed by Carbide and Carbon Chemicals Corp., which is said to be based on catalytic isomerization of propylene oxide.

It has recently been announced that Shell Chemical Corporation in the U.S.A. are going ahead with the commercial manufacture of glycerol by the synthesis indicated above, and this will have a very useful stabilizing effect upon glycerol prices in the U.S.A. Glycerol is of value to the textile industry as a conditioning and finishing agent and as a base material in the manufacture of alkyd resins which may find considerably extended application as textile finishing agents.

Butylenes

The butylenes yield a similar series of alcohols and ketones to that obtained from propylene.

Detergents

In the cracking of normal gas oils or fuel oil the resulting products consist of mixtures of hydrocarbons of different types. By selecting waxy materials as the feed-stock for cracking, products containing a high concentration of olefins are obtained. In one process, a fraction consisting largely of olefins ranging from 6 to 20 carbon atoms can readily be obtained. By adopting exactly the same principle as in the manufacture of *iso*propyl alcohol, a suitable cut of these olefin mixtures can be directly sulphated and neutralized to give sodium *secondary*—alkyl sulphates, which form the basis of synthetic detergents now widely accepted in Britain.

The production of synthetic detergents represents another major development in petroleum chemistry which provides a useful alternative source of processing materials for the textile industry, in many cases yielding results superior to soap and other established wetting agents manufactured from natural oils or fats. U.S.A. opinion estimates the ceiling of production of synthetic detergents of all types at about 500,000 tons per annum,[5] i.e., about one-third of the pre-war soap production.

Natural Gas

The use of natural gas as a raw material for the petroleum chemical industry is primarily of importance to the U.S.A., while in other countries cracked gas is a more likely raw material. Similar hydrocarbons produced in Germany by the Fischer-Tropsch synthesis from coal provide an alternative starting-point.

It is convenient in the first place to consider the reactions of methane as being largely representative of natural gas. High-temperature cracking of natural gas completely decomposes natural gas or methane into its elements, carbon and hydrogen. This process has been developed by the Shell Chemical Corporation in America for the large-scale manufacture of ammonia, an alternative source of a raw material of fundamental importance to the textile industry, both for the manufacture of amines, e.g., hexamethylene diamine for the synthesis of nylons and also indirectly in the manufacture of cuprammonium rayon.

Methane can be treated with sulphur to yield carbon disulphide, and full-scale manufacture is now being carried out by this process in the U.S.A. Carbon disulphide is, of course, one of the major raw materials used in the preparation of cellulose xanthate in the manufacture of viscose rayon, which still remains the most important of the man-made fibres in their challenge to the natural materials.

By electric arc pyrolysis methane can be converted into acetylene, and a process involving the partial oxidation of propane has been used in Germany and the U.S.A. This opens up enormous possibilities as acetylene is a raw material of great value. Apart from ethylene, acetylene is the main source of

supply of vinyl chloride from which vinyon type of fibres are manufactured; acetylene can lead also, via acetaldehyde, to acetic acid and acetic anhydride, both of prime importance in the manufacture of cellulose acetate, and of vinyl acetate for copolymerization to vinyon.

Chlorination of methane leads to methyl chloride, widely used in the preparation of methyl cellulose, a product of considerable interest for textile-finishing purposes, sizes, etc. Chlorination can yield also methylene dichloride, a solvent for cellulose acetate, alternative to acetone.

Direct oxidation of methane yields formaldehyde, and oxidation with steam leads to methyl alcohol (methanol). Formaldehyde is a well-known chemical raw material used as a cross-linking agent in semi-synthetic protein fibres as well as in the manufacture of a number of important synthetic resins such as phenol-formaldehyde, urea-formaldehyde, and melamine-formaldehyde. All of these find application in textile finishes and coatings or laminates.

An important development in Germany during the war was the successful operation of Fischer-Tropsch plants for the manufacture of hydrocarbons from coke. Certain of the paraffin hydrocarbon fractions of longer chain-length unsuitable for motor spirit were used in the manufacture of a synthetic detergent known as Mersolates. These were obtained by reaction with sulphur dioxide and chlorine in the presence of light to give the sulphonyl chloride which is converted to the sodium sulphonate by treatment with caustic soda. The same process can, of course, be applied to paraffinic fractions from petroleum. Mersolates were widely used in Germany both for household soaps and as textile detergents. Among the hydrocarbon fractions produced by the Fischer-Tropsch process were soft waxes, which were successfully oxidized catalytically to yield high molecular weight fatty acids for the manufacture of synthetic soaps. This process can be operated on waxes of petroleum origin.

One of the most interesting developments recently announced in the U.S.A. is the erection of two full-scale plants by the Standard Oil Co. of Indiana and Carthage Hydrocol Corporation, for the operation of Fischer-Tropsch synthesis as modified by Keith, in which natural gas is used as the raw material in place of coke.[5] The estimated production of oxygenated products from one of the plants at Hugoton is given in Table III.

It will be apparent that the availability of this range of chemicals from yet another petroleum source will be of major importance to the textile industry as far as the production of acetone and the lower fatty acids are concerned.

A further development in Germany was the manufacture of aldehydes, alcohols, and acids by the oxo process. This depended fundamentally on the

TABLE III

Estimated Production of Chemicals from the Hugoton Plant (Keith Process)

(long tons per annum)

Methyl alcohol	330	Acetaldehyde	4,070
Ethyl alcohol	28,450	Propionaldehyde	860
n-Propyl alcohol	6,430	Butyraldehyde	1,230
n-Butyl alcohol	1,950		
Amyl alcohol	470	Acetone	5,000
		Methyl ethyl ketone	2,130
Acetic acid	5,530	Methyl propyl ketone	270
Propionic acid	3,890	Methyl *iso*propyl ketone	110
Butyric acid	1,870		
		Total	62,590

reaction of a mixture of water gas and olefins passed over heated catalyst.

Among other reactions of saturated hydrocarbons may be mentioned the production of acetic acid by controlled oxidation of propane and similarly of propionic acid from butane and butyric acid from pentane. This provides another source for the straight chain acids valuable in the manufacture of modified cellulose acetate fibres, e.g., Tenite II, Forticel, and Fortisan.

A commercial application of a reaction of paraffins of considerable importance is the chlorination of a suitable kerosine fraction to give the α-derivative, which is then treated with benzene to give the alkyl benzene (more specifically referred to as kerylbenzene), which on subsequent sulphonation and neutralization yields sodium alkaryl-sulphonates.

A similar type of detergent can also be prepared by alkylation of benzene with an olefin, such as propylene tetramer, to give an alkyl benzene which can be sulphonated and neutralized.

Aromatics

Until comparatively recently it was the general impression that while petroleum had become the source of supply for chemicals of the aliphatic class, coal-tar would remain the raw material for the aromatic products. Such progress has, however, been made in the production of aromatic chemicals, particularly of toluene, that it can now be stated categorically that almost every organic chemical, whether cyclic or non-cyclic, can be produced, usually economically, from petroleum sources.

The production of aromatic chemicals from petroleum sources is again likely to be a factor of fundamental importance in the development of certain of the newer synthetic fibres, more particularly nylon and Terylene, both of which represent "tailor made" chemicals or polymers, whose construction has been based upon theoretical considerations in order to arrive at the desired properties. Although nylon has been much publicized as being derived ultimately from coal, air, and water, it is understood that one of the plants operated by du Pont in the U.S.A. is relying upon *cyclo*-hexane from petroleum sources for production of adipic acid. Reference has already been made to the availability of ammonia from petroleum sources, so that it is quite possible to synthesize this fibre completely from petroleum chemicals. Terylene represents fundamentally a modification of a polyethylene glycol structure in which an aromatic group is introduced into the methylene polymer chain, which has the desirable effect of increasing the melting-point of the polymer. The aromatic group must be such as to give a symmetrical molecule,[6] so that *tere*phthalic acid is the most favoured raw material. Since this may be obtained from *p*-xylene from petroleum as well as from coal-tar sources, and the ethylene glycol also from petroleum olefins, it is again possible to produce this material wholly from petroleum sources.

Among other applications to which brief mention must be made are the use of petroleum-derived toluene for dye intermediates, of cresols and alkyl phenols for resins used in textile finishing and for the manufacture of alkyl aryl sulphonate detergents, and of *o*-xylene for phthalic anhydride for glyptal resins.

Economic Considerations

It has been shown that the expansion of the cellulose acetate industry owes much to the manufacture of acetic anhydride from propylene and that the majority of the true synthetic fibres such as Vinyon, Saran, polythene, and polystyrene are almost entirely dependent upon petroleum-derived chemicals for their raw material, while the newest fibres of all, the nylons and Terylene, may also be based upon chemicals from this source. There can be no doubt then that the petroleum chemical industry is a force of very great importance, both in

the U.S.A. and in Britain. It is clear that production of petroleum chemicals has already reached a very high figure in the U.S.A. and that further expansion there may be expected to develop mainly in the preparation of completely new organic chemicals of a reactive nature, for which a market has yet to be built up, and in the extension in the production of pure aromatic hydrocarbons from petroleum.

Since little or no natural gas is available in Britain, it is clear that those hydrocarbons, whether saturated or unsaturated, which can be obtained in a satisfactory yield by a cracking of heavier hydrocarbon fractions, either deliberately or as a by-product in cracking for motor spirit manufacture, must form the basis of any development in the petroleum chemical industry in Britain.

Let us now consider the potentialities of the three main sources of raw materials for the chemical industry. It has recently been estimated[7] that in spite of an increase in production of coal in the U.S.A. from 362,000,000 tons in 1938 to 553,000,000 tons in 1946, the world coal gap at present is 75,000,000 tons annually. Since the major part of the increased U.S.A. output is taken up in meeting America's own domestic needs, the true deficiency in Europe alone works out at close on 160,000,000 tons.

Turning to the vegetable sources, we find one of the largest chemical manufacturers in Britain, hitherto using grain or molasses as the raw materials for alcohol production, turning to the petroleum industry for raw materials. In his annual report to the shareholders the chairman of a major soap company has referred to the world-wide shortage of oils and fats which may be expected to last some considerable time, and to the fact that his company were prepared to manufacture high-quality synthetic detergents from any satisfactory alternative source and would not, in future, necessarily be restricted to oils and fats.

Although at the present time there is also a very heavy demand for petroleum products for fuel and power, it should be remembered that in the manufacture of chemicals from this source those products which are of low value from a power point of view, are the major raw materials and that according to Russell,[8] of the total world crude production of oil annually, less than 1 per cent would cover the world's alcohol requirements for all purposes, and one-half of 1 per cent would supply the world's entire rubber needs. The wide range of chemical products being made from oil at the present time, impressive though it is, and amounting in the U.S.A. to 28 per cent of the total organic chemical production, still utilizes only a fraction of 1 per cent of the total world oil production. In addition, the man-power requirements to operate large-scale production processes of chemicals from petroleum are among the lowest of all industries. Thus, for instance, in the new chemical plant which Shell are erecting at Thornton, the total personnel required to operate a plant producing some 25,000 tons per annum of solvents is only 300.

It would thus seem clear that for many years to come, both on grounds of economics and availability and also on technical versatility, petroleum represents the most attractive source of raw materials for the chemical and allied industries, not least the textile industry. This same argument applies not only in the petroleum-producing countries, but in any highly industrialized areas where sufficiently large markets can be found to allow for the large-scale manufacture of chemicals by continuous methods.

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The author wishes to thank Shell Chemicals Ltd. for permission to publish this paper.

THE STORY OF THE NATIONAL SUPPLY CO.

An attractive booklet has recently been issued by the National Supply Co., giving its history from its incorporation in 1894. Liberally illustrated with drawings and photographs, it is in effect a history of the development of drilling methods. Copies are available from the company at Grant Building, Pittsburgh, Pa., U.S.A.

"NOTES ABOUT OIL"

Under this title the Petroleum Information Bureau has issued a 12-page foolscap pamphlet, giving data useful in particular to the unitiated. It points out that while the modern world takes oil for granted the story of petroleum is full of interest. Line diagrams illustrate the text, and copies are available from the Bureau at 29 New Bond Street, London, W.1.

Change of Address.—The Public Relations Department of Manchester Oil Refinery Ltd., Petrocarbon Ltd., and Petrochemicals Ltd., has moved to 44A Dover Street, London, W.1. ('phone: REGent 7602.)

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

Modern Trend in Tanker Construction. John Lamb. At 26 Portland Place, London, W.1, 5.30 p.m. (tea 5 p.m.), March 9.

The Viscosity of Aero-Engine Oils at Low Temperatures. S. G. Daniel. At 26 Portland Place, London, W.1, 5.30 p.m. (tea 5 p.m.), April 13.

Examination of Crude Oils in Relation to Geological Formations. F. Morton. At 26 Portland Place, London, W.1, 5.30 p.m. (tea 5 p.m.), May 11.

LONDON BRANCH

International Trading Problems and the Oil Industry. P. M. de Veulle. At 26 Portland Place, London, W.1, 6 p.m. (tea [1*s*.] 5.30 p.m.), March 22.

Oilfield Development. J. B. Kay. At 26 Portland Place, London, W.1, 6 p.m. (tea [1*s*.] 5.30 p.m.), April 26.

SCOTTISH BRANCH

The Coal Tar Industry—A Review. F. M. Potter. At North British Station Hotel, Edinburgh, 7.30 p.m., March 23.

MEETINGS OF OTHER SOCIETIES

The Future of Synthetic Detergents in Relation to the Petroleum Chemical Industry. F. H. Braybrook and A. K. Simcox. Society of Chemical Industry, in Agricultural Lecture Theatre, Elmwood Avenue, Belfast, 7.30 p.m., March 2

The Modern Processing of Oils and Resins. H. C. Worsdale. Oil and Colour Chemists' Association, at Royal Station Hotel, Hull, 6.30 p.m., March 7.

Application of Vacuum to Industrial Chemical Processes. J. Leyland. **Production of Vacuum for Industrial Chemical Processes.** G. Arrowsmith. Institution of Chemical Engineers, at Geological Society, Burlington House, London, W.1, 5 p.m., March 8.

Sulphur in Diesel Fuels. J. J. Broeze and A. Wilson. Institution of Mechanical Engineers (Automobile Division), Storey's Gate, St. James's Park, London, 6 p.m., March 8.

Analytical Chemistry as a Profession. F. J. Clark. Royal Institute of Chemistry, at Municipal Technical College, Widnes, 7 p.m., March 9.

Solvent Extraction as a Unit Process. J. C. Wood-Mallock. Institution of Chemical Engineers, at Reynolds Hall, College of Technology, Manchester, 3 p.m., March 12.

The Principles of Diesel Engine Waste Heat Recovery. T. R. Houston. Diesel Engine Users' Assoc. At Caxton Hall, London, S.W.1, 2.30 p.m., March 17.

Synthetic Detergents. E. S. Paice. Royal Institute of Chemistry, The University, Bristol, 7 p.m., March 17.

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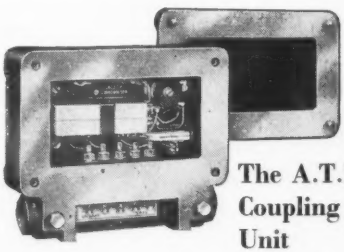

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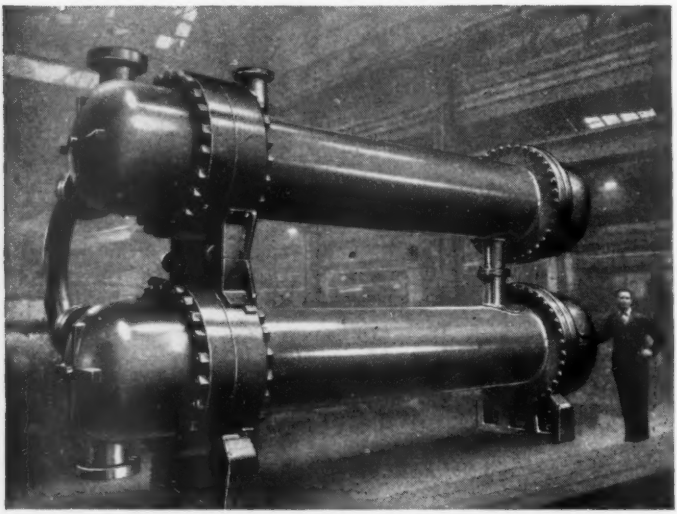

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